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Ethnopharmacological versus random plant selection methods for the evaluation of the antimycobacterial activity

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Article

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Abstract: The municipality of Oriximiná, Brazil, has 33 *quilombola* communities in remote areas, endowed with wide experience in the use of medicinal plants. An ethnobotanical survey was carried out in five of these communities. A free-listing method directed for the survey of species locally indicated against Tuberculosis and lung problems was also applied. Data were analyzed by quantitative techniques: saliency index and major use agreement. Thirty four informants related 254 ethnospecies. Among these, 43 were surveyed for possible antimycobacterial activity. As a result of those informations, ten species obtained from the ethnodirected approach (ETHNO) and eighteen species obtained from the random approach (RANDOM) were assayed against *Mycobacterium tuberculosis* by the microdilution method, using resazurin as an indicator of cell viability. The best results for antimycobacterial activity were obtained of some plants selected by the ethnopharmacological approach (50% ETHNO x 16,7% RANDOM). These results can be even more significant if we consider that the therapeutic success obtained among the *quilombola* practice is complex, being the use of some plants acting as fortifying agents, depurative, vomitory, purgative and bitter remedy, especially to infectious diseases, of great importance to the communities in the curing or recovering of health as a whole.

Keywords:
bioprospecting
quilombola communities
traditional knowledge
ethnopharmacological
random approach

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Introduction

Tuberculosis (TB) is the main cause of death by infectious illnesses in the world. It is estimated that approximately 1/3 of the world population may be infected with the TB bacillus, *Mycobacterium tuberculosis* (Singh, 2004; Maher & Raviglione, 2005). According to data of the Brazilian Ministry of Health (MS/SVS, 2005), Brazil has an average incidence rate of 43,78 cases of TB per 100,000 inhabitants; and in the Pará state the average is of 50,15 cases per 100,000 inhabitants. In 2005, the municipality of Oriximiná presented an alarming number of TB cases, 95,98 cases per 100,000 inhabitants (MS/UFPA, 2009). This heterogeneous geospatial distribution of TB cases in different regions of the country keeps a close relationship to their socioeconomic conditions. In the Amazon region, major part of the population suffers from chronic problems of malnutrition, precarious habitation and sanitation. In addition, the forest people who live in remote areas, far from civilization, have great difficulty in accessing primary health care (Basta et al., 2004). Another factor that has favored the higher incidence of TB in the North is the fact that there live about 60% of the indigenous population and that they have suffered real epidemics of the disease with an incidence 10 times higher in relation to TB average of the Brazilian population (Coimbra Jr. & Basta, 2007).

The progression of TB is mainly governed by the integrity of the host immune response, which may be effective in the microbial control shown by the action of macrophages, CD4 lymphocytes, interferon gamma and tumor necrosis factor. But in many cases, the bacillus cannot be destroyed and can remain in dormant state for years. Between 90 to 95% of those infected people fail to express the active form of the disease. However, others manifest the disease, usually in a condition of immunosuppression (Ducati et al., 2006; Barker, 2008). The inflammatory and pathologic processes produce symptoms typical of TB such as fever, weakness, weight loss, night sweats, chest pain, dyspnea, and cough. The pathology in advanced stages can also lead to the rupture of blood vessels causing hemoptysis (Baker, 2008).

TB has been considered a neglected disease, with little investment in research to develop new drugs. This is changing recently, according to the gravity and danger that TB represents, with its high rate of morbidity and mortality and the unavailability of new drugs to control and cure patients with resistant strains to multiple drugs (MDR) and extensively resistant to multiple drugs (XDR) (Rivers & Mancera, 2008).

Medicinal plants have attracted great interest as a source for finding new efficient drugs or prototypes to TB treatment, and the literature is covered with many examples of plant selection methods based on random or ethnopharmacological approaches (Cantrell et al., 1998; Newton et al., 2002; Leitão et al., 2006; Gautam et al., 2007; McGaw et al., 2008; Ramos et al., 2008; Mohamad et al., 2011).

The vast Amazonian biodiversity together with the traditional knowledge of the forest people could represent a potential source for the discovery of new therapeutic agents, including against TB. The city of Oriximiná, Pará State, Brazil, has 33 quilombola communities (Oliveira et al., 2010). These communities are ethnic groups with historical background, specific territorial relations, and presumption of black ancestry related to resistance to oppression suffered historically. In the late 18th and early 19th centuries the slaves that were used on cocoa, coffee, and cotton plantations as a labor force, fled to remote areas, especially to regions of lakes and waterfalls that were difficult to access. Many of these communities are still in full contact with the natural biodiversity of regions far from the urban area of Oriximiná. Their close contact with nature over centuries, the knowledge formed from an Indian-Black-Portuguese complex, and their geographic isolation, have brought to the members of these communities a vast knowledge of medicinal plants (Oliveira et al., 2011a).

In December 2007, the Federal University of Rio de Janeiro obtained the first approval in Brazil to access the traditional knowledge for bioprospecting purposes in quilombola communities from Oriximiná (Oliveira et al., 2010). This work reports part of the vast knowledge of the *quilombola* people from Oriximiná (Oliveira, 2009) and aimed at the bioprospection of the medicinal plants used by them for TB-related diseases by ethnopharcological approach and a comparison between random plant selection methods for the evaluation of the antimycobacterial activity.

Material and Methods

Characterization of the search area

The municipality of Oriximiná is located in northern Brazil, in the State of Pará, and has an area of 107,603 km^2, being the second largest municipality in the Brazilian territory. It borders Suriname, Guyana, and French Guiana to the north, the cities of Faro, Juruti, and Óbidos to the South and East, and the States of Amazonas and Roraima to the West. According to data from the 2010 census, Oriximiná has 62,963inhabitants, being 40,182 in urban areas and 22,781 in rural areas (IBGE, 2010).

Currently, there are 33 known "quilombola" communities in the municipality of Oriximiná, which are divided into eight territories (Água Fria, Boa Vista, Trombetas, Erepecuru, Alto Trombetas, Jamari/Último Quilombo, Moura, and Ariramba) that, together, encompass more than 600,000 hectares (Figure 1). The "quilombolas" were represented by their association called Associação de Comunidades Remanescentes de Quilombos do Município de Oriximiná – ARQMO (Association of the Remaining of "Quilombo" Communities from the Municipality of Oriximiná). In this work, five communities, representing two "quilombola" areas were chosen: Bacabal and Arancuã-de-Cima from the Trombetas region, as well as Serrinha, Jauari, and Pancada, from the Erepecuru region (Figure 1).

Ethnopharmacological data collection

This work has received authorization for access to the traditional knowledge associated with bioprospecting purposes by the Directing Council of Genetic Heritage (Conselho de Gestão do Patrimônio Genético), through the Resolution no. 213 (6.12.2007), published in the Federal Official Gazette of Brazil on 27 December 2007 (Oliveira et al., 2010).

The selection of the interviewees began with the search for key informants who were respected people in the community, such as the community coordinator, matriarch or patriarch, and/or community health agent. Eventually, they led to the local specialists, who were "quilombolas" with wide experience in the use of medicinal plants, such as extractivists, woodsmen, healers, faith healers, prayer ladies, midwives, and "puxadores" or "puxadoras", who are like traditional chiropractors. For data acquisition four ethnobotanical field trips were performed between the period of June 2006 (after signing the Prior Informed Consent between UFRJ and ARQMO), until the month of September 2008. Each field work had a residence period of 30 to 60 days in the communities studied.

Ethnobotanical data was collected through

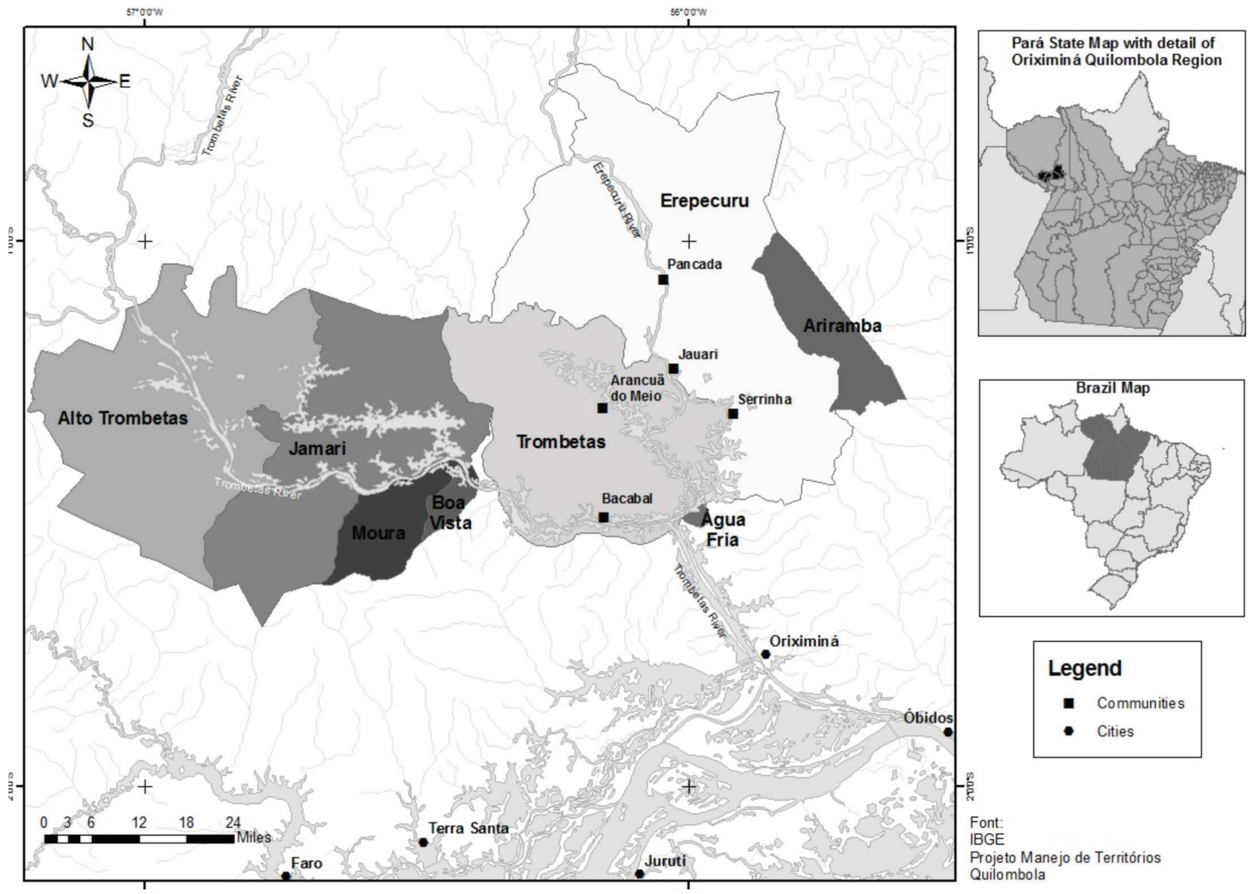

Figure 1. Map representing the "quilombola" area and the studied communities of Oriximiná, Pará State, Brazil.

semi-structured interviews, participating observation and walk in the woods (Albuquerque & Lucena 2004). The formularies applied contain socio-economic data (sex, age, professional, level of schooling, monthly family income, number of residents) and the medicinal plants information (common name, therapeutic indications, doses, preparation methods, counterindications and the local to obtain it). Thirty five quilombolas from the five communities studied, twenty women and fifteen men, were interviewed. Participants included four women and two men from Arancuã-do-meio, nine women and two men from Bacabal, three women and five men from Jauari, one women and four men from Pancada and three women and two men from Serrinha. They were between 19 and 87 years old. They survive mainly by fishing, hunting, and subsistence farming, and their only source of income is the extraction of the Pará nut ("Brazil nut"), which is available for only a few months of the year.

Quantitative data analysis techniques, such as the free-list salience index (S), and corrected major use agreement (MUAc), were also applied.

Free-List and Salience Index (S)

The free-list technique can identify items within an emic category or a cultural domain, and it offers a direct method to obtain data easily and simply. It is also used as an exploratory technique (Oliveira et al., 2011a,b). Using this technique, a direct list of the medicinal plants known and used by the informers was obtained, with the aim of searching for specific information on this cultural domain within the communities and its diffusion. Additionally, an ethnodirected inquiry regarding the plants used against TB and lung problems was conducted employing a glossary with the emic illnesses or symptoms like cough, dry cough, "whooping cough" ("tosse braba"), pneumonia, "weakness", tuberculosis, lung problem or illness, and infectious diseases of chest These therapeutic terms used locally were obtained in a previous study carried out in Oriximiná city (Oliveira, 2004) and through participant observation and ethnographic techniques. Taken together, these approaches suggest the most important cultural elements and the order of their importance (Albuquerque & Lucena, 2004). The S was calculated using the program ANTHROPAC 4.0 (Analytic Technologies, USA).

Major Use Agreement (MUA):

The Major Use Agreement (MUA) is a quantitative technique used to evaluate the agreement between the main uses cited by various informants (Oliveira et al., 2006). It is determined by the ratio between the number of informers who independently cited the species for a major use (MU) and the total number of informers who mentioned that species for any use (total uses, TU_s).

$$MUA = \frac{MU}{TU_s} \times 100$$

A correction factor (CF) was applied to calculate the corrected MUA (MUA_c), given by the formula: $MUA_c = MUA \times CF$. The correction factor is the ratio between the number of informers citing each species for any use (TU_s) and the highest number of informers citing the most-cited species. In this study, *Dipteryx odorata* was the most-cited species and was cited by 24 informers (TU_s+) (Oliveira et al., 2011a).

$$CF = \frac{TU_s}{TU_{s+}}$$

Collection and identification of plant material

Plants were collected by one of the authors (DRO). with informants and woodsmen of the "quilombola" communities. Specimens were deposited at the Herbarium of the Amazonia National Institute of Research (INPA), where the parataxonomist Mr. José Ferreira Ramos, and specialists in specific botanical families, such as Dr. Fátima Salimena (Verbenaceae), Dr. Washington Marcondes-Ferreira (Apocynaceae), and Dr. Kátia Calago (Asteraceae), provided botanical identifications. Voucher numbers of plants collected by ethnopharmacological approach are listed in Table 1. Voucher number for plants collected by random approach: *Acrocomia aculeata* (Jacq.) Lodd. ex Mart. (INPA 224624), *Ampelozizyphus amazonicus* Ducke (INPA 224161), *Anacardium giganteum* W.Hanc. exEngl. (INPA 224700), *Aspidosperma excelsum* Benth. (INPA 224704), *Aspidosperma rigidum* Rusby (INPA 224692), *Bauhinia platycalyx* Benth. (INPA 223277), *Brosimum potabile* Ducke (INPA 224693), *Brosimum* sp. (without voucher number), *Couepia paraensis* (Mart.&Zucc.) Benth. (INPA 224627), *Cucurbita moschata* (Duch.) Duch.e xPoir. (INPA 223273), *Endopleura uchi* (Huber) Cuatrec. (INPA 224690), *Machaerium ferox* Mart. (INPA 233440), *Operculina alata* (Ham.) Urb. (INPA 223281), *Simaba cedron* (Rol) Ward (INPA 223283), S*pondias mombin* L. (INPA 224699), *Trichilia quadrijuga* Kunth (INPA 224620), *Uncaria guianensis* (Aubl.) Wild. (INPA 224608), *Virola surinamensis* (Rol) Ward. (INPA 224143).

Selection the plant species and the preparation of the extracts

The ETHNO plants (ten species) were selected from the free-listing for TB; and related diseases and the RANDOM pants (eighteen species) were selected by the other important medicinal uses in the communities, but not used for lung disturbances.

Plant materials used for the preparation of extracts (Table 2) were air-dried, powdered, and macerated with ethanol to make ethanolic extracts. Aqueous extracts were obtained by decoction prepared at 1% (w/v), approaching the traditional method of use. Saps and latex were obtained directly from incisions or perforations of the plants. Teas, saps, and latex were freeze-dried.

Isolates and strain preparation of Mycobacterium tuberculosis

Mycobacterium tuberculosis $H_{37}Rv$ (ATCC-27294) pan-susceptible strain was used for all experiments in both microbiology laboratories (FURG and Fiocruz). Additional assays with a rifampicin-resistant strain (ATCC 35338, His-526-Tir) were performed at the FURG laboratory. The isolates were maintained in Ogawa-Kudoh medium for ca. 14 days. The bacterial suspensions were prepared in sterile water containing 3-mm glass beads. The suspensions were homogenized by vortex agitation and turbidity was adjusted in agreement with tube one of the McFarland scale (3.2×10^6 colony-forming units/mL). The inoculums were prepared by diluting the bacterial suspension 1:20 in Middlebrook 7H9 OADC medium (4.7 g Middlebrook 7H9 base; Difco, Becton Dickinson USA) enriched with 10% (v/v) oleic acid-dextrose-albumin-catalase (BBL).

In vitro *evaluation of antimycobacterial activity*

Plant extracts selected by ethnodirected method (ETHNO) obtained with the free-list and by random method (RANDOM) were screened against *M. tuberculosis* $H_{37}Rv$ strain by microdilution method using resazurin as indicator of cell viability. Initially, a fixed concentration of 200 μg/mL was used. Media plus bacteria, with and without rifampicin, were used as positive and negative controls, respectively. For the active samples and the positive control, the minimum inhibitory concentration (MIC) was determined.

Data analyses

The Chi-square Test and Fisher Exact Test were used to analyze differences between the positive and negative results obtained by the ETHNO and RANDOM, employing the statistical package SigmaStat 3.0 (Jandel Scientific, USA).

Results and Discussion

Thirty four individuals were interviewed, who reported 254 ethnospecies and a total of 2,508 use indications. Among these, 233 plant species were identified, belonging to 211 genera and 72 botanical families (Oliveira et al., 2011a). Another survey was conducted to assess the plants used by the "quilombolas" to treat TB and TB-related diseases and symptoms. In the communities, there isn't a clear perception and clinical diagnosis of TB. In this way, an ethnodirected method of free-list focusing on cough, dry cough, "whooping cough" ("tosse braba"), pneumonia, "weakness", tuberculosis, lung problem or illness, and infectious diseases of chest was employed, which led to the survey of 43 ethnospecies, displayed in Table 1, listed in order of their Salience (S). They are distributed into 29 botanical families, being Fabaceae the most well represented family (18.3%), principally for subfamily Caesalpinioideae.

Out of these 43 ethnospecies, only seven were cited by more than 20% of the interviewees (Frequency - FR≥20%) for TB-related diseases; seven displayed a Salience value (S) above 0.1; and eight had a MUAc value higher than 25%. So, at least five ethnospecies - represented by seven identified plant species have potential for TB bioprospecting by ETHNO. They are: *Dipteryx odorata* (S=0,541; MUAc=79,2%; Fr=64,5%), *Chenopodium ambrosioides* (S=0,24; MUAc=45,8%; Fr=45,2%), *Hymenaea courbaril, H. intermedia, H. oblongifolia* (S=0,179; MUAc=41,7%; FR=29%), *Plectranthus amboinicus* (S=0,163; MUAc=37,5%; Fr=25,8%) and *Cereus* sp (S=0,12; MUAc=41,7%; Fr=22,6%).

The symptoms of TB appear confused with other bronchial and respiratory diseases as well as malnutrition and weakness. Moreover, older people in these communities refer to TB as the "weakening". The body weakness as a factor for the development of TB, in the view of traditional communities, is reported by other authors (Maués, 1990; Santos & Muaze, 2002), and is extremely well discussed globally that TB is a disease that manifests itself often in cases of disability or low immune

Table 1. Ethnospecies listed in order of the Salience values for diseases and symptoms related to TB and the respective MUA and MUAc.

Species	Ethnospecies	Voucher number	Diseases and symptoms related to TB*	S	TI	MUA (%)	MUAc (%)	FR (%)
Dipteryx odorata (Aubl.) Willd. Fabaceae-Faboideae	cumaru	INPA 224607	pneumonia (19), cough (11), TB (2)	0.541	24	79.2	79.2	64.5
Chenopodium ambrosioides L. Chenopodiaceae	Mastruz	INPA 224606	cough (11), pneumonia (7), TB (6)	0.24	20	55.0	45.8	45.2
Hymenaea courbaril L., *Hymenaea intermedia* Ducke, *Hymenaea oblongifolia* Huber Fabaceae-Caesalpinioideae	jutaí/jatobá	INPA 224658, INPA 223296, INPA 223297	cough (10), hoarseness (2), TB (3), pneumonia (1)	0.179	17	58.8	41.7	29
Himatanthus sucuuba (Spruce ex Müll. Arg.) Woodson Apocynaceae	sucuuba	INPA 224151	cough (6), pneumonia (2), illness of chest (2), TB (2)	0.174	16	37.5	25.0	22.6
Plectranthus amboinicus (Lour.) Spreng. Lamiaceae	hortelã-grande	INPA 224639	cough (9), pneumonia (3)	0.163	13	69.2	37.5	25.8
Jatropha curcas L. Euphorbiaceae	peão-branco	INPA 224670	pneumonia (4), TB (1), cough (2)	0.123	23	17.4	16.7	22.6
Cereus sp. Cactaceae	Jaramacaru	INPA 224611	cough (10), TB/weakness (1), illness of chest (1)	0.12	11	90.9	41.7	22.6
Anacardium occidentale L. Anacardiaceae	cajueiro	INPA 224167	pneumonia (2), cough (1)	0.085	9	22.2	8.3	9.7
Eryngium foetidum L. Apiaceae	chicória	INPA 223295	cough (4)	0.082	12	33.3	16.7	16.1
Ruta graveolens L.Rutaceae	arruda	INPA 224600	pneumonia (3), cough (2), illness of chest (1)	0.081	19	15.8	12.5	9.7
Parahancornia amapa Ducke Moraceae	amapá-amargo	INPA 224693	cough (3), TB (3)	0.075	7	42.9	12.5	16.1
Mangifera indica Wall. Anacardiaceae	mangueira	INPA 224636	cough (5), pneumonia (1)	0.073	8	62.5	20.8	9.7
Ocimum americanum L. Lamiaceae	esturaque	INPA 224614	cough (6), pneumonia (1)	0.063	10	60.0	25.0	16.1
Bertholletia excelsa Kunth. Lecythidaceae	castanheira/ castanha-do-pará	INPA 224171	pneumonia (2), cough (1)	0.057	16	12.5	8.3	9.7

Portulaca pilosa L. Portulacacea	amor-crescido	INPA 223286	pneumonia (2), TB (1)	0.053	14	14.3	8.3	6.5
Bryophyllum calycinum Salisb. Crassulaceae	diabinho	INPA 224141	TB (3), cough (3)	0.05	9	33.3	12.5	9.7
Luffa operculata Cogn. Curcubitaceae	cabacinha	INPA 224139	pneumonia (3), cough (2)	0.036	9	33.3	12.5	9.7
Orthopappus angustifolius (Sw.) Gleason Asteraceae	língua-de-vaca	INPA 223284	TB (1), cough (1)	0.036	3	33.3	4.2	6.5
Carapa guianensis Aubl. Meliaceae	andiroba	INPA 223282	cough (7), chest pain (1), pneumonia (1)	0.036	16	43.8	29.2	6.5
Allium sativum L.Liliaceae	alho	Without Voucher Number	cough (5)	0.032	16	31.3	20.8	9.7
Justicia pectoralis Jacq. Acanthaceae	trevo-cumaru	INPA 224671	pneumonia (2)	0.032	4	50.0	8.3	3.2
Piper cf. *dactylostigmum* Yunck. Piperaceae	pau-de-angola	INPA 224137	pneumonia (1)	0.032	2	50.0	4.2	3.2
Dalbergia riedelii (Benth.) Sandw. Fabaceae- Faboideae	verônica	INPA 224158	pneumonia (1)	0.032	6	16.7	4.2	3.2
Pouteria sp. Sapotaceae	cramuri	INPA 224628	TB (1)	0.032	7	14.3	4.2	3.2
Physalis angulata L. Solanaceae	gamapú	INPA 224149	pneumonia (1)	0.032	2	50.0	4.2	3.2
Sesamum indicum L. Pedaliaceae	gergelim	INPA 224675	illness of chest (1)	0.032	11	9.1	4.2	3.2
Zingiber officinale Roscoe Zingiberaceae	mangarataia	INPA 224604	cough (4)	0.028	10	40.0	16.7	3.2
Cedrela odorata L. Meliaceae	cedro	INPA 223380	pneumonia (1)	0.027	5	20.0	4.2	6.5
Eupatorium triplinerve Vahl. Asteraceae	japana	INPA 224678	cough (3)	0.026	10	30.0	12.5	6.5
Citrus limon (L.) Burm. f. Rutaceae	limão	INPA 224613	cough (5)	0.024	21	23.8	20.8	3.2
Inga bourgoni (Aubl.) DC. Fabaceae-Mimosoideae	ingá-xixica	INPA 223279	cough (1)	0.024	5	20.0	4.2	3.2
Campsiandra comosa Benth. Fabaceae-Caesalpinioideae	manaiara	INPA 223288	illness of chest (1)	0.022	11	9.1	4.2	3.2
Aniba canelilla (Kunth) Mez. Lauraceae	preciosa	INPA 224705	pneumonia (1)	0.022	8	12.5	4.2	6.5
Copaifera sp. Fabaceae-Caesalpinioideae	copaíba	Without Voucher Number	cough (3)	0.016	13	23.1	12.5	3.2
Caesalpinia ferrea Mart. Fabaceae-Caesalpinioideae	jucá	INPA 224643	catarrh (1), cough (1)	0.016	7	14.3	4.2	3.2
Allium cepa L. Liliaceae	cebola	Without Voucher Number	cough (2)	0.012	3	66.7	8.3	3.2
Davilla kunthii A. St.-Hil. Dilleniaceae	cipó-d'água	INPA 224163	whooping cough (1)	0.011	3	33.3	4.2	3.2
Leucas martinicensis R.Br. Lamiaceae	catinga-de-mulata	INPA 233361	TB (1), cough (1), pneumonia (1)	0.008	8	12.5	4.2	3.2
Psidium guajava L. Myrtaceae	goiabeira	INPA 224145	cough (1)	0.008	6	16.7	4.2	3.2
Lippia origanoides Kunth Verbenaceae	salva-de-marajó	CESJ 39532	lung (1)	0.007	10	10.0	4.2	3.2
Cinnamomum zeylanicum Blume Lauraceae	canela	INPA 224156	TB (1)	0.006	7	14.3	4.2	3.2
Polypodium decumanum Willd. Polypodiaceae	guaribinha	INPA 223280	whooping cough (4)	0.005	4	100.0	16.7	3.2
Cissus sicyoides L. Vitaceae	cipó-pucá	INPA 223271	pneumonia (1)	0.004	4	25.0	4.2	3.2

S=Salience Index; TI= total of the interviewed that cited the ethnospecies; MUA= Major Use Agreement; MUAc= Corrected MUA; *In the column "diseases and symptoms related to TB" the symptom used to calculate the Major Use Agreement and Corrected MUA is highlighted in bold, while between parentheses is the number of times that the plant was cited for this indication.

system, especially in the case of individuals with Acquired Immune Deficiency Syndrome (AIDS) and those who suffer from chronic malnutrition. Therefore, many times, the indicated remedies are the same one to treat respiratory problems in general and to treat anemia and to fortify the body.

Beyond the medicinal plants, a curious question is the use of the "queixada" tooth for treatment of pneumonia or TB in the quilombola communities of Oriximiná. This use has also been reported also in Amazonian communities of the valley of the rivers Purus and Acre (Santos & Muaze, 2002). "Queixada" (*Tayassu pecari* Link.) it is an Amazonian wild boar frequently used in the feeding of the communities studied. They can be very aggressive when confronted. When angry, it snaps its teeth in order to warn the intruder that it is about to attack. The use of teeth in the treatment of "weakening" probably gives the strength and stiffness of the teeth of the species, as well as the dry and shrill sound emitted by queixada when it is angry or threatened. The tooth should be dried (or toasted) and ground to then be used alone or in combination with some of the plants listed in Table 1.

As a result of the plant use information for the lung disturbances and related diseases, ten species were tested by ethnodirected method (ETHNO) and eighteen by random method (RANDOM) for antimycobacterial activity. In the screening eight species gave positive results with MIC varying between 12,5-200 µg/mL, being five selected by ETHNO, and three by RANDOM (Table 2). The best result was obtained by ETHNO, because 50% of the species tested had some activity, while by RANDOM only 16.7% of species had some activity (Table 2). Most of the natural products from plant sources do not display strikingly potent activities (Newton et al., 2000), and for most of them, published MIC ranges of substances considered to show modest activity lay between 50 to 216 µg/ml (Okunade et al., 2004). Among all positive samples *Dipteryx odorata* (ETHNO) and *Aspidosperma* spp. (RANDOM) showed MIC below 25 µg/mL, which can be considered a good activity for ethanolic crude extracts when compared with the antimycobacterial literature for medicinal plants. Five plant extracts (*Dipteryx odorata, Campsiandra comosa, Machaerium ferox, Aspidosperma excelsum* and *A. rigidium*) were active against both strains of *M. tuberculosis* indicating the absence of a cross-resistance to RMP when the molecular basis of resistance is *rpo*B His-526-Tir mutation (Table 2). Importantly, this mutation is one of the most common in RMP resistan strains. In this study the target and possible antimicrobial mechanism of action these extracts was not identified, although it is possible that the antimicrobial activity is due to a single molecule or could also be the result of a synergic action among various compounds.

Table 2. Antimycobacterial activity and Minimum Inhibitory Concentration (MIC) of plant samples selected by ETHNO (E) and RANDOM (R) methods against *Mycobacterium tuberculosis*.

Species	Selection method	Plant part	Extract	H37Rv strain		35338 strain	
				200 µg/mL	MIC (µg/mL)	200 µg/mL	MIC (µg/mL)
Cumaru *Dipteryx odorata* (Aubl.) Willd.	E	bark	ethanol	(+)	12.5	(+)	12.5
		seed	water	(-)	-----	(-)	-----
		seed	oil	(-)	-----	(-)	-----
Jutaí *Hymenea courbaril* L.	E	bark	ethanol	(-)	-----	(-)	-----
Jutaí Pororoca *Hymenea intermedia* Ducke	E	bark	ethanol	(-)	-----	(-)	-----
		sap	-	(-)	-----	(-)	-----
Mangueira *Mangifera indica* Wall.	E	stalk	ethanol	(+)	> 200	(+)	>200
			water	(-)	-----	(-)	-----
Amapá-amargo *Parahancornia amapa* Ducke	E	bark	ethanol	(-)	-----	(-)	-----
Manaiara *Campsiandra comosa* (Benth.) Cowan	E	seed	ethanol	(+)	200	(+)	100
		bark	ethanol	(-)	-----	(-)	-----
Amor-crescido *Portulaca pilosa* L.	E	leaves	ethanol	(-)	-----	(-)	-----
Andiroba *Carapa guianensis* Aubl.	E	seed	oil	(+)	> 200	(-)	-----
Castanheira *Bertholletia excelsa* Kunth.	E	bark	ethanol	(-)	-----	(-)	-----
		collumela	ethanol	(-)	-----	(-)	-----
		fruit bark	ethanol	(-)	-----	(-)	-----
		bark	juice	(-)	-----	(-)	-----

Amapá-doce *Brosimum potabile* Ducke	R	bark	latex	(-)	-----	(-)	-----
Saratudo *Machaerium ferox* Mart.	R	bark	ethanol	(+)	200	(+)	100
		sap	-	(-)	-----	(-)	-----
Cajuaçú *Anacardium giganteum* W.Hanc. ex Engl.	R	bark	ethanol	(-)	-----	(-)	-----
			water	(-)	-----	(-)	-----
Mururé *Brosimum* sp.	R	bark	latex	(-)	-----	(-)	-----
Ucuuba *Virola surinamensis* (Rol) Ward	R	bark	latex	(-)	-----	(-)	-----
Saracuramirá *Ampelozizyphus amazonicus* Ducke	R	bark	water	(-)	-----	(-)	-----
Pau-paratudo *Simaba cedron* (Rol) Ward	R	bark	water	(-)	-----	(-)	-----
Escada-de-jabuti *Bauhinia platycalyx* Benth.	R	bark	ethanol	(-)	-----	(-)	-----
		root	ethanol	(-)	-----	(-)	-----
Jamaru *Cucurbita moschata* (Duch.) Duch.e xPoir.	R	leaves	ethanol	(-)	-----	(-)	-----
Uxirana *Couepia paraensis* (Mart.&Zucc.) Benth.	R	bark	ethanol	(-)	-----	(-)	-----
Mucajá *Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	R	bark	ethanol	(-)	-----	(-)	-----
Taperebá *Spondias mombin* L.	R	bark	ethanol	(-)	-----	(-)	-----
Uxi-Liso *Endopleura uchi* (Huber) Cuatrec.	R	bark	water	(-)	-----	(-)	-----
Batatão *Operculina alata* (Ham.) Urb.	R	potate	water	(-)	-----	(-)	-----
Unha-de-gato *Uncaria guianensis* (Aubl.) Wild.	R	bark	water	(-)	-----	(-)	-----
Grajió *Trichilia quadrijuga* Kunth	R	bark	water	(-)	-----	(-)	-----
Carapanaúba *Aspidosperma excelsum* Benth.	R	Bark	ethanol	(+)	50	(+)	25
			water	(-)	-----	(-)	-----
Carapanaúba *Aspidosperma rigidum* Rusby	R	bark	ethanol	(+)	>200	(+)	25
				(-)	-----	(-)	-----
Rifampicin	Positive control			(+)	0.03	(+)	8g/mL

(+) = active/sensible; (-) = not active/resistant

The ethnopharmacological data show the importance of *Dipteryx odorata* (cumarú = tonka been) in the treatment of pulmonary illnesses, by the highest salience index (S=0.541), corrected major use agreement (MUAc=79.2%) and frequency of citation (RF=64.5%). These data are consistent with the good antimycobacterial activity obtained for the crude ethanol extract from their barks (MIC 12.5 µg/mL). However, the seeds did not show positive results at the concentrations tested.

From the barks of *Dipteryx odorata* were isolated the triterpene lupeol, a mixture of fatty acid methyl esthers, the flavonoid luteolin, plus several isoflavonoids (Nakano & Suárez, 1969; Hayashi & Thompson, 1974; Nakano et al., 1979; Nakano & Yoshimura, 1979; Socorro et al., 2003). The MIC of 12.5 µg/mL obtained for cumarú barks, against both strains of *M. tuberculosis*, may be related to the presence of diterpenes, triterpenes, fatty acids and isoflavones, since these natural product classes have several representatives with known antimycobacterial activity described in the literature (Cantrell et al., 2001; Copp, 2003; Okunade et al., 2004; Carballeira, 2008). Considering that the cumarú positive sample was a crude ethanolic extract, this result becomes very promising for the identification of bioactive substances. Aspidosperma rigidum and *Aspidosperma excelsum*, known as carapanaúba, are rich in indole alkaloids (Vieira et al. 2010) and antimycobacterial activity has already been recently demonstrated for several substances of this class (Copp, 2003; Okunade et al., 2004), as well as for other species of the Apocynaceae family (Case et al., 2006; Gautam et al., 2007; Ramos et al., 2008; Mohamad et al., 2011).

Some species such as *Allium cepa, Anacardium occidentale, Cynnamomum zeylanicum, Jatropha curcas, Psidium guajava* and *Zingiber officinale* in Malaysian (Mohamad et al., 2011), besides *Chenopodium ambrosioides, Ruta graveolens, Ocimum americanum, Allium sativum* and *Mangifera indica* in Índia (Gautam et al., 2007) are also indicated as a possible source of new antimycobacterial agents, and in South Africa, *Ruta graveolens* has also highlighted its potential (McGaw et al., 2008).

It is expected that the traditional knowledge about medicinal plants indicates the presence of biologically active substances. The collection of plants for biological testing from its traditional use can be a great advantage, or a shortcut, increasing the chances of discovering new drugs (Elisabetsky & Shanley, 1994; Soejarto, 1996). Table 3 shows the enormous potential of the ethnopharmacological approach found in several studies, compared with the randomized.

Table 3. Comparison between Ethnopharmacological and Random approaches in the search for different biological activities.

Biological Activities	RANDOM (%)	ETHNO (%)	References
Antineoplastic	6	25	Elisabetsky & Shanley, 1994
Antihypertensive	31	44	Adsersen & Adsersen, 1997
Antihelmintic	9.8	29.3	Bourdy et al., 2008
Icthyotoxicity	9.6	38.6	Bourdy et al., 2008
Toxic/venoms	10.5	52.2	Bourdy et al., 2008
Anti-HIV	8.5	71.4	Slish et al., 1999
Antimicrobial	22	37	Boily & van Puyvelde, 1986
Antiplasmodial	0.7	18	Carvalho & Krettli, 1991
Acetylcholinesterase inhibition	8	42.3	Oliveira et al., 2011a

In this study, the best results for antimycobacterial activity were also obtained with the ethnopharmacological approach - 50% ETHNO x 16,7% RANDOM (Table 2), however, because of the limited number of the samples, it was not found significant difference (p>0,05) between these approaches by the use of the Chi square and Fisher exact tests. *Dipteryx odorata* is the species with the highest salience index and showed a good antimycobaterial activity (MIC 12.5 µg/mL). This result points out a preference towards the ethnopharmacological information. In recent work published by our group (Oliveira et al., 2011a), the ethnodirected approach using the salience index and the major use agreement also improved the probability of finding activity species for acetylcholinesterase inhibition. In contrast, the study of Case et al. (2006) that used the informant consensus model (informant agreement ratio) to select plants used in traditional medicine for persistent respiratory symptoms among the Manus (Papua New Guinea), was inaccurate in predicting antimycobacterial activity plants. However, these authors related that “Due to the complexity of the human body, it cannot be assumed that in vitro bioassay results translate to human systems, for either a positive or negative result. Consequently, the species identified in the survey may be beneficial in the treatment of TB for many reasons apart from direct antimycobacterial activity, *e.g.*, they may provide symptomatic relief from cough or have immunostimulatory effects. It must also be noted that the *in vitro* test may not be predictive of activity *in vivo*. With infinite resources, samples could be submitted to other relevant assays such as immune-modulating assays to better understand and assess the biological activity of traditional medicine” (Case et al., 2006). Oliveira et al. (2011a,b) discuss that some plants could have an adaptogen effect that contribute to quilombola health by an unspecific way. Some plants have the role of panacea, being used to cure all ills.

In the “quilombola” communities of Oriximiná TB is often called the “weakening”. So, the ETHNO's good results can be even more significant considering that the therapeutic practices among the “quilombolas” from Oriximiná are complex. The use of fortifying agents, depuratives, vomitory agents, purgatives, bitter remedies, as well as curing infectious diseases, weakness, and memory loss, play an important role in the processes of curing diseases and/or health recovery, acting as order to restore overall health (Oliveira et al., 2011a,b). Similar data were surveyed by Rodrigues & Carlini (2004; 2006) in the Sesmaria quilombola community in the State of Mato-Grosso, in a transition area between Cerrado and Pantanal biomes, where certain species are characteristic for their versatility, or nonspecific therapy, is also employed for rejuvenation, to energize, to muscle building and to fortify the brain. Another study at the Pará State also showed a substantial number of general “cure alls” or panaceas, fortifiers, tonics, nerve tonics and aphrodisiacs, as a reflex of the caboclo culture (Branch & Silva, 1983; Berg, 1984; Amoroso & Gély, 1988).

A broad literature review about the 43 cited ethnospecies, used against TB and TB-related diseases and symptoms, revealed that 93% of them have been described as useful for the treatment of respiratory diseases and 86% were indicated as tonic and stimulant, corroborating with the ETHNO information (Table 4).

Table 4. Literature data review about the 43 ethnospecies employed in "quilombola" communities to treat TB and TB-related diseases and their publicated indications for use as a tonic/stimulant/fotifier, or to treat TB and TB-related diseases.

Ethnospecies	Tonic/fortifier/stimulant	TB and TB-related diseases
Alho *Allium sativum*	Almeida, 1993; PDR, 2007	Cruz, 1982; Martins, 1989; Vieira, 1992; Almeida, 1993; Ming, et al. 1997; Maciel & Cardoso, 2003; Oliveira, 2004; Maciel & Guarim-Neto, 2006; PDR, 2007; Pinto & Barbosa, 2009; Mosca & Loiola, 2009.
Amapá *Parahancornia amapa*	Figueiredo, 1979; Branch & Silva, 1983; Berg & Silva, 1986; Amorozo & Gèly, 1988; Rodrigues, 1989; Schultes & Raffauf, 1990; Vieira, 1992; MEB, 1993; Berg, 1993; Tenório et al., 1991; Revilla, 2002; Pinto & Barbosa, 2009.	Figueiredo, 1979; Berg & Silva, 1988; Rodrigues, 1989; Martins, 1989; MEB, 1993; Tenório et al., 1991; Vieira, 1992; Revilla, 2002; Oliveira, 2004; Rodrigues, 2006; Pinto & Barbosa, 2009.
Amor Crescido *Portulaca pilosa*	Corrêa, 1926; Cid, 1978;	Ducke & Martinez, 1994;
Andiroba *Carapa guianensis*	Cid, 1978; Corrêa, 1926; Matta, 2003; Rodrigues, 2006	Branch & Silva, 1983; MEB, 1993; Berg & Silva, 1986; Berg, 1993; Revilla, 2002; Rodrigues, 2006; Pinto & Barbosa, 2009
Arruda *Ruta graveolens*	Corrêa, 1926; Cruz, 1982; Branch & Silva, 1983; Martins, 1989; Oliveira et al. 2011a	Teixeira et al., 1991; MEB, 1993; Di Stasi & Hiruma-Lima, 2002; Oliveira, 2004
Batatão *Operculina alata*	Branch & Silva, 1983; Cruz, 1982; Matos, 2007	Matos, 2007
Cabacinha *Luffa operculata*	------------------------------	Tenório et al., 1991; Gupta, 1995; Revilla, 2002; De La Cruz, 2008; Mosca & Loiola, 2009
Cajueiro *Anacardium occidentale*	Corrêa, 1926; Cruz, 1982; Rodrigues, 1989; Vieira, 1992; Almeida, 1993; Gupta, 1995; Revilla, 2002; Matta, 2003; Matos et al., 2004	Corrêa, 1926; Cruz, 1982; Gupta, 1995; Revilla, 2002; Matta, 2003; Ramos et al, 2005
Canela *Cinammomum zeylanicum*	Corrêa, 1926; Cid, 1978; Figueiredo, 1979; Martins, 1989; Amorozo & Gèly, 1988; Tenório et al., 1991; Vieira, 1992; Schardong & Cervi, 2000; Maciel & Cardoso, 2003; Oliveira et al. 2011a	Cid, 1978; Tenório et al., 1991; Vieira, 1992; Souza et al., 2004; PDR, 2007
Castanheira *Bertholletia excelsa*	Oliveira, 2004; Pinto & Barbosa, 2009; Oliveira et al. 2011a	Ming, 1997; Oliveira, 2004
Catinga-de-mulata *Leucas martinicensis*	Corrêa, 1926; Cid, 1978; Tenório et al., 1991; Vieira, 1992; Di Stasi & Hiruma-Lima, 2002; Lorenzi & Matos, 2002	Di Stasi & Hiruma-Lima, 2002; Revilla, 2002; Pinto & Barbosa, 2009
Cebola *Allium cepa*	Vieira, 1992; PDR, 2007	Corrêa, 1926; Vieira, 1992; Almeida, 1993; PDR, 2007; Monteles & Pinheiro, 2007; Pasa et al., 2008
Cedro *Cedrela odorata*	Cid, 1978; Vieira, 1982; Matta, 2003	Branch & Silva, 1983; Amorozo & Gèly, 1988; MEB 1993; Revilla, 2002;
Chicória *Eryngium foetidum*	Corrêa, 1926; Lorenzi & Matos, 2002; Rodrigues, 2006	Amorozo & Gèly, 1988; Vieira, 1992; Berg, 1993; Ming, 1997; Revilla, 2002; Rodrigues, 2006
Cipó-pucá *Cissus sicyoides*	Branch & Silva, 1983; Ducke & Martinez, 1994; Revilla, 2002	Almeida, 1993; MEB 1993; Ducke & Martinez, 1994; Gupta, 1995; Revilla, 2002
Copaíba *Copaifera* sp.	Corrêa, 1926; Branch & Silva, 1983; Revilla, 2002; Matta, 2003; PDR, 2007;	Corrêa, 1926; Cid, 1978; Berg & Silva, 1986; Tenório et al., 1991; Vieira, 1992; MEB, 1993; Revilla, 2002; Lorenzi & Matos, 2002; Oliveira, 2004; PDR, 2007; De La Cruz, 2008
Cumaru *Dipteryx odorata*	Cruz, 1982; Rodrigues, 1989; Vieira, 1992; Ducke & Martinez, 1994; Oliveira et al. 2011a	Figueiredo, 1979; Branch & Silva, 1983; Vieira, 1992; Ducke & Martinez, 1994; Di Stasi & Hiruma-Lima, 2002; Matta, 2003; Oliveira, 2004; PDR, 2007; Pinto & Barbosa, 2009
Diabinho *Bryophyllum calycinum*	Rodrigues, 2006	Corrêa, 1926; Almeida, 1993; Ming, et al., 1997; Rodrigues, 2006; Berg, 1993; Vieira, 1992; Lorenzi & Matos, 2002; Oliveira, 2004; Albuquerque et al., 2007; De La Cruz, 2008; Pinto & Barbosa, 2009
Esturaque	------------------------------	Nadembega et al., 2011
Gergelim *Sesamum indicum*	Cid, 1978; Cruz, 1982; Almeida, 1993; Martins, 1989; Revilla, 2002;	Amorozo & Gèly, 1988; MEB, 1993; Di Stasi & Hiruma-Lima, 2002

Goiaba *Psidium guajava*	Gupta, 1995	Gupta, 1995; Pasa et al., 2008
Guaribinha *Polypodium decumanum*	------------------------------	Figueiredo, 1979; Branch & Silva, 1983; Amorozo & Gèly, 1988; Schultes & Raffauf, 1990; Berg, 1993; Ming, 1997; Lorenzi & Matos, 2002; Oliveira, 2004
Hortelã-grande *Plectranthus amboinicus*	Tenório et al., 1991; Revilla, 2002;	Vieira, 1992; Berg, 1993; Longuefosse & Nossin, 1996; Ming, 1997; Lorenzi & Matos, 2002; Oliveira, 2004; IEPA, 2005; Ramos et al, 2005; Albuquerque et al., 2007; Monteles & Pinheiro, 2007; Mosca & Loiola, 2009
Japana *Eupatorium triplinerve*	Cid, 1978; Corrêa, 1926; Rodrigues, 1989; Di Stasi & Hiruma-Lima, 2002; Matta, 2003	Figueiredo, 1979; Vieira, 1992; Berg, 1993; Longuefosse & Nossin, 1996; Pinto & Barbosa, 2009
Jaramacaru Cereus sp.	Cruz, 1982; Rodrigues, 1989.	Corrêa, 1926; Cid, 1978; Figueiredo, 1979; Branch & Silva, 1983; Berg & Silva, 1986; Amorozo & Gèly, 1988; Rodrigues, 1989; Martins, 1989; Vieira, 1992; Berg, 1993; Lorenzi & Matos, 2002; Revilla, 2002; Agra et al., 2007; Pinto & Barbosa, 2009
Jucá *Caesalpinia ferrea*	Branch & Silva, 1983; De La Cruz, 2008; Pinto & Barbosa, 2009	Cid, 1978; Figueiredo, 1979; Cruz, 1982; Amorozo & Gèly, 1988; Tenório et al., 1991; Vieira, 1992; Almeida, 1993; Di Stasi & Hiruma-Lima, 2002; Revilla, 2002; Matta, 2003; Oliveira, 2004; Ramos et al, 2005; Albuquerque et al., 2007
Jutaí/Jatobá *Hymenaea spp.*	Corrêa, 1926; Figueiredo, 1979; Cruz, 1982; Branch & Silva, 1983; Berg & Silva, 1986; Rodrigues, 1989; Tenório et al., 1991; Vieira, 1992; Berg, 1993; Almeida, 1993; Lorenzi & Matos, 2002; Revilla, 2002; Di Stasi & Hiruma-Lima, 2002; Oliveira, 2004; Rodrigues, 2006; Matos, 2007; De La Cruz, 2008; Pinto & Barbosa, 2009; Oliveira et al. 2011a;	Corrêa, 1926; Cid, 1978; Cruz, 1982; Branch & Silva, 1983; Berg, 1984; Berg & Silva, 1986; Berg & Silva, 1988; Amorozo & Gèly, 1988; Vieira, 1992; Berg, 1993; Ducke & Martinez, 1994; Gupta, 1995; Ming, 1997; Lorenzi & Matos, 2002; Revilla, 2002; Di Stasi & Hiruma-Lima, 2002; Matta, 2003; Oliveira, 2004; Ramos et al, 2005; Franco & Barros, 2006; Maciel & Guarim-Neto, 2006; Rodrigues, 2006; Matos, 2007; Albuquerque et al., 2007; De La Cruz, 2008; Pasa et al., 2008; Pinto & Barbosa, 2009
Limão *Citrus limon*	Corrêa, 1926; Cruz, 1982; Branch & Silva, 1983; Martins, 1989; Teixeira et al., 1991; Rodrigues, 2006; PDR, 2007	Cruz, 1982; Branch & Silva, 1983; Teixeira et al., 1991; Vieira, 1992; Berg, 1993; Schardong & Cervi, 2000; Oliveira, 2004; Monteles & Pinheiro, 2007; PDR, 2007; Pasa et al., 2008; Pinto & Barbosa, 2009
Língua-de-vaca Orthopappus angustifolius	Cruz, 1982	Amorozo & Gèly, 1988; Martins, 1989; Cruz, 1982; Vieira, 1992; Oliveira, 2004
Manaiara *Campsiandra comosa*	Corrêa, 1926; Oliveira et al. 2011a	---
Mangarataia *Zingiber officinale*	Corrêa, 1926; Cid, 1978; Cruz, 1982; Branch & Silva, 1983; Martins, 1989; Teixeira et al., 1991; Di Stasi & Hiruma-Lima, 2002; Rodrigues, 2006; Oliveira et al. 2011a	Corrêa, 1926; Figueiredo, 1979; Martins, 1989; Teixeira et al., 1991; Vieira, 1992; Ducke & Martinez, 1994; Schardong & Cervi, 2000; Revilla, 2002; Di Stasi & Hiruma-Lima, 2002; Oliveira, 2004; De La Cruz, 2008; Pinto & Barbosa, 2009
Mangueira Mangifera indica	Branch & Silva, 1983	Cruz, 1982; Branch & Silva, 1983; Guarim-Neto, 1987; Amorozo & Gèly, 1988; Vieira, 1992; MEB, 1993; Berg, 1993; Longuefosse & Nossin, 1996; Schardong & Cervi, 2000; Oliveira, 2004; Rodrigues, 2006; Maciel & Guarim-Neto, 2006; Monteles & Pinheiro, 2007; Pasa et al., 2008; Mosca & Loiola, 2009; Nadembega et al., 2011
Mastruz *Chenopodium ambrosioides*	Branch & Silva, 1983; Berg & Silva, 1988; Tenório et al., 1991; Berg, 1993; Matta, 2003; Rodrigues, 2006; Matos, 2007; Oliveira et al. 2011a	Branch & Silva, 1983; Rodrigues, 1989; Tenório et al., 1991; Vieira, 1992; Almeida, 1993; MEB, 1993; Berg, 1993; Ducke & Martinez, 1994; Lorenzi & Matos, 2002; Revilla, 2002; Maciel & Cardoso, 2003; Matos et al., 2004; Ramos et al, 2005; Franco & Barros, 2006; Rodrigues, 2006; Matos, 2007; Albuquerque et al., 2007; De La Cruz, 2008; Pinto & Barbosa, 2009; Mosca & Loiola, 2009

Pau-de-angola *Piper cf. dactylostigmum*	------------------------------	Tenório et al., 1991
Peão-branco *Jatropha curcas*	Rodrigues, 2006; Oliveira et al. 2011a	Berg, 1984; Amorozo & Gèly, 1988; Vieira, 1992; Revilla, 2002; Di Stasi & Hiruma-Lima, 2002; Rodrigues, 2006; Pinto & Barbosa, 2009
Preciosa Aniba canellila	Corrêa, 1926; Cid, 1978; Figueiredo, 1979; Schultes & Raffauf, 1990; Tenório et al., 1991; Vieira, 1992; Berg, 1993; Matta, 2003	Corrêa, 1926; Cid, 1978; Figueiredo, 1979; Berg, 1993; Almeida, 1993
Salva-de-marajó *Lippia origanoides*	Rodrigues, 1989; Vieira, 1992; Berg, 1993; Matta, 2003; Matta, 2003	Berg, 1993; Pinto & Barbosa, 2009
Sucuuba *Himatanthus sucuuba*	Martins, 1989; Pinto & Barbosa, 2009; Oliveira et al. 2011a	Branch & Silva, 1983; Berg & Silva, 1986; Amorozo & Gèly, 1988; Berg & Silva, 1988; Vieira, 1992; Berg, 1993; MEB, 1993; Ducke & Martinez, 1994; Lorenzi & Matos, 2002; Oliveira, 2004; Franco & Barros, 2006; Pinto & Barbosa, 2009
Trevo-cumaru *Justicia pectoralis*	Gupta, 1995; Matos et al., 2004	Ducke & Martinez, 1994; Gupta, 1995; Longuefosse & Nossin, 1996; Lorenzi & Matos, 2002; Matos et al., 2004; Ramos et al, 2005; Matos, 2007; Albuquerque et al., 2007
Verônica *Dalbergia riedelii*	Cid, 1978; Figueiredo, 1979; Rodrigues, 1989; Berg, 1993; Oliveira, 2004; Pinto & Barbosa, 2009	Cid, 1978; Rodrigues, 1989; Berg, 1993

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